IMPROVED KEYBOARD SUPPORT MECHANISM

Cross-Reference to Related Applications

This application is a continuation-in-part of Provisional U.S. Application Serial No. 60/040,972, filed March 12, 1997 in the name of the same inventors and bearing the same title.

Field of the Invention

This invention relates to improved adjustable support mechanisms for keyboards and other items.

Background of the Invention

The use of computers for both personal and business use has become so common that it is fair to say that almost all businesses, and many homes, have at least one computer or computer terminal. Computers are particularly prevalent in the office environment. Among the health issues which have become increasingly important as the use of computers has become more common is the need to promote proper posture while using the computer so as to both maintain working efficiency and minimize the occurrence of repetitive stress injuries. One basic principal which has been developed to address these issues is that the computer keyboard should be used while at a level considerably below the level of most desktops, so the user's wrists, when the keyboard is in use, are a "neutral" position; that is, the surface defined by the user's forearms and the

top of his or her hands is flat. In addition to regulating the height at which the keyboard is used, it is also important for ergonomic purposes to control the angle which the keyboard shelf makes with the ground.

There have been a number of devices which have been developed for use in supporting keyboards (and associated computer accessories, such as a computer mouse) at a level below the surface of a desk while in use and underneath the desk when not in use. One such device is described in Smeenge, et al., U.S. Patent No. 4,616,798, which discloses the use of a parallelogram linkage to connect a shelf for holding a keyboard to the underside of the desk surface. The overall system described by Smeenge permits a fair degree of flexibility in positioning the keyboard relative to the user and the desk. One disadvantage of Smeenge's system is that the parallelogram linkage used by the system is attached to the underside of the keyboard support shelf. Therefore, when the keyboard is positioned underneath the desk, the leg room available to the user between the bottom of the mechanism and the floor is limited.

McConnell, U.S. Patent No. 5,257,767 attempted to address this deficiency of the Smeenge mechanism by using a non-parallelogram linkage to connect the keyboard shelf to the underside of the desk. This non-parallelogram linkage causes the front of the keyboard shelf to be angled upwards when the shelf is lowered relative to the desk top, marginally increasing the leg room available to the user when the keyboard is positioned beneath the desk. Like the Smeenge mechanism, the McConnell mechanism has its linkage attached to the bottom of the keyboard shelf, which limits the total leg room available to the user.

Summary of the Invention

In one aspect, this invention improves upon the prior art mechanisms by the use of a novel linkage between the underside of the desk and the keyboard shelf, which novel linkage increases the leg room available to the user. The improved mechanism of this invention permits the adjustment of the angle of the keyboard shelf relative to the ground within certain parameters so that the angle is ergonomically correct for the vast majority of users.

The mechanism according to this aspect of the invention comprises a novel articulating arm mechanism for permitting vertical movement of the keyboard shelf. The articulating arm mechanism has six major components: (1) a mounting bracket, (2) a mounting bracket support in combination with a swivel bracket, (3) a shelf bracket, (4) an upper arm, (5) at least one side arm, and (6) at least one stopping means. The upper arm links the shelf bracket and the mounting bracket; the side arm and the stopping means cooperate to keep the shelf bracket at a constant angle relative to the ground.

A second aspect of the invention comprises the attachment of a linkage between a desk and a keyboard shelf so that nothing extends beneath the bottom of the keyboard shelf.

Brief Description of the Drawings

FIG. 1 is an exploded, perspective view of the auxiliary shelf mechanism of the invention.

FIG. 2 is a side elevational view of the auxiliary shelf mechanism in its downward and retracted position. Those parts of the mechanism which would not ordinarily be seen from this angle are shown in dotted lines; a keyboard is also shown in dotted lines, but does not form part of the invention.

FIG. 3 is a top plan view of an adjustable stopping means for use in the auxiliary shelf mechanism of the invention.

FIG. 4 is a side elevational view, similar to the view in FIG. 2, showing the auxiliary shelf mechanism in an extended and upward position.

FIG. 5 is a top plan view showing the auxiliary shelf mechanism as attached to a desk. The dotted lines show how the auxiliary shelf mechanism may be rotated relative to the desk, which is also shown in dotted lines.

FIG. 6 is a front elevational view of the auxiliary shelf mechanism, showing the means by which the mechanism can be made to rotate as shown in FIG. 4.

FIG. 7 is a side elevational view of a portion of a different embodiment of the invention, showing a movable stopping means. The dotted lines show the stopping means in a different position.

FIG. 8 is a side elevational view of the portion of the invention shown in FIG. 7, showing slightly different details of the movable stopping means.

FIG. 9 is a top view of an embodiment of the invention, showing a movable stopping means.

FIG. 10 is a top view of a portion of an embodiment of the invention, showing a stopping means with a chamfer in combination with a section of the mounting bracket.

FIG. 11 shows the same view as shown in FIG. 10, with the stopping means with a chamfer and a portion of the mounting bracket, with the additional showing of the side arm.

FIG. 12 shows a side view of an alternate embodiment of the side arm in combination with the stopping means.

FIG. 13 is a bottom elevational view of a different movable stopping means.

FIG. 14 is a bottom view of the embodiment shown in FIG. 13.

FIG. 15 is a top elevational view of element of the mechanism used to allow the stopping means to move as shown in FIG. 13.

FIG. 16 is a top elevational view of a different element of the mechanism used to allow the stopping means to move as shown in FIG. 13.

FIG. 17 is a bottom elevational view of a different movable stopping means.

FIG. 18 is a bottom view of the embodiment shown in FIG. 17.

FIG. 19 is a top elevational view of an element of the mechanism used to allow the stopping means to move as shown in FIG. 17.

Detailed Description

As used in this specification and the appended claims, the term "desk" means any desk, table, shelf, or other suitable work surface. The term "desk top" means the working surface of a desk (i.e. the surface facing upwards). The term "front" when

applied to any component of the auxiliary shelf mechanism means the end closest to the user; the term "back" means the part farthest away from the user.

Referring to FIG. 1, there is illustrated an exploded view of an auxiliary shelf mechanism **1** according to the invention. Auxiliary shelf mechanism **1** includes an upper arm **2**, a mounting bracket **3**, a shelf bracket **4**, and a pair of side arms **5**. Though two side arms **5** are shown in FIG. 1 and constitute the preferred embodiment, only one side arm is required. Attached to mounting bracket **3** is a mounting bracket support **6** (shown in FIG. 6) in combination with swivel bracket **32** and swivel bracket support **33**. The combination of the swivel bracket **33** and the mounting bracket support is illustrated in further detail in FIG. 6. A first pivot rod **7** connects mounting bracket **3** to upper arm **2** at paired pivot points **8**, secured by washers **9** and push nuts **10**. Upper arm **2** is attached to shelf bracket **4** by means of second pivot rod **11** through holes **12** (one such hole is not shown).

Side arms **5** are attached to shelf bracket **4** by means of third pivot rod **13**. The use of two side arms **5** is preferred and illustrated because this arrangement enhances stability of shelf bracket **4**, but only one is necessary. Side arms **5** are attached to mounting bracket **3** by means of bolt **14**, which extends through holes **15** in the mounting bracket **3** (one not shown) and through first openings **16** in the side arms. Spacer **41** is wrapped around bolt **14** and is wider than first openings **16**, so as to prevent it from sliding out from between side arms **5** via first openings **16**. Spacer **41** provides assistance in locking the mechanism in place, as described more fully below. One end of bolt **14** is square (this end is not shown in drawing). The square end can either be part of bolt **14** as manufactured or can be a cover which is slipped onto the round end. The square end

prevents bolt **14** from rotating due to the interaction of the square end with first opening **16**.

add A17 A curved end **21** of each side arm **5** projects behind first openings **16** away from shelf bracket **4**. Lower arm **17** is not required, but is included in the preferred embodiments shown in the drawings. Lower arm **17** is attached to upper arm **2** by means of fourth pivot rod **18** through holes **19** (one not shown) in upper arm **2**. Lower arm **17** is also attached to both side arms **5** and mounting bracket **3** by means of bolt **14**. Bolt **14** passes through lower arm **17** through second openings **20** (one not shown).

As shown in FIG. 2, auxiliary shelf mechanism **1** may be attached to the underside of a desk top **36** by means of mounting track **22**. Mounting track **22** is affixed to the underside of desk top **36** by conventional means, such as nails or screws. Swivel bracket support **33** cooperates with mounting track **22** as is more fully shown in FIG. 6 to permit auxiliary shelf mechanism **1** to slide back and forth relative to mounting track **22**. Also shown in FIG. 2 is stopping means **23**, which is attached to mounting bracket **3**. Stopping means **23** has a first side **24** which faces towards the curved end **21** of the side arm. There is one first side **24** for each side arm **5**. Preferably, though not necessarily, first side **24** is concave in shape, as shown in the different figures.

In an embodiment where the stopping means is adjustable and when two side arms are used, the two first sides **24** can form part of a single stopping means, which consequently has a C-shaped top profile, as shown in FIG. 3 (the first sides **24** representing the ends of the short parts of the "C" **37**), with the open side of the "C" facing towards the front. The center piece **38** connecting the two sides of the stopping means **23** can have its lateral position relative to mounting bracket **3** adjusted by means of

knob **27**, as described more fully below, or by any other means. When two side arms **5** are used, but stopping means **23** is not adjustable, two stopping means may be used, each of which may be attached in a fixed manner by spot-welding or flat riveting (or other conventional means) to the side of mounting bracket **3**.

Keyboard **25** (not part of this invention) can rest directly on shelf bracket **4**, as shown in the drawing. Preferably, however, an additional, wider keyboard shelf (not shown) is attached to shelf bracket **4** through attachment holes **26** (as shown in FIG. 1), on which can rest the keyboard. Additional components, such as a supplemental shelf for a computer mouse or pad of paper may be attached to the keyboard shelf (or directly to shelf bracket **4**).

In the preferred embodiment, upper arm **2**, lower arm **17**, and mounting bracket **3** thereby form a wedge-shaped box whose surfaces are made up of the top of upper arm **2**, the base of lower arm **17**, and the overlapping sides of upper arm **2** and lower arms **17**, and whose edges are defined by first pivot rod **7**, fourth pivot rod **18**, and bolt **14**. From the side, as shown in FIG. 2, the system resembles a triangle, which can be pivoted to permit the raising or lowering of shelf bracket **4** relative to mounting bracket **3**, and hence the top of the desk **36**. As upper arm **2** pivots about first pivot rod **7**, lower arm **17** both pivots about bolt **14** and slides forward or backward relative to it, via first ~~and second openings **16** and **20**.~~

Curved ends **21** of side arms **5** contact first sides **24** of stopping means **23**. This prevents side arms **5** from sliding rearwards, relative to bolt **14**, past the point where side arms **5** contact the first sides **24** of the stopping means **23**. When first sides **24** have a concave shape, this point varies as side arms **5** are pivoted around bolt **14**. By

positioning stopping means **23** at a specific distance behind bolt **14**, and giving first sides **24** of stopping means **23** a particular degree of curvature (which may be easily determined by one of ordinary skill in the art), shelf bracket **4** can be kept at consistent angle relative to the ground, regardless of the height of shelf bracket **4** relative to mounting bracket **3**.

Side arms **5** are kept in contact with the first sides **23** of stopping means **24** by means of the arrangement of shelf bracket **4**, upper arm **2**, and side arms **5**. Upper arm **2** is pivotally connected to shelf bracket **4** by means of second pivot rod **11**. Therefore, the weight of shelf bracket **4** (plus the weight of anything else attached to it or resting on it) will tend to force shelf bracket **4** to pivot around first pivot rod **11**. This pivoting action forces third pivot rod **13** backwards, in turn forcing side arm **5** (attached to shelf bracket **4** by means of third pivot rod **13**) back into the first sides **24** of stopping means **23**. Thus, side arms **5** will always be in contact with stopping means **23**, keeping shelf bracket **4** at a consistent horizontal orientation.

The relative movements of the various components of the mechanism as shelf bracket **4** is moved in a vertical direction can best be appreciated by comparing their positions as shown in FIGS. 2 and 4, which depict auxiliary shelf mechanism **1** in a retracted, downward position and in an extended, forward position respectively.

It is preferable to upwardly bias auxiliary shelf mechanism **1** slightly, by means of a torsion spring **39**, or other types of springs (e.g. leaf springs) or other conventional mechanisms, such as a compressible fluid cylinder.

Stopping means **23** can be fixed in position during the manufacturing process by any conventional means. Among the means for fixing it are spot welding or

flat riveting. Fixing the stopping means in position ensures that the horizontal orientation of shelf bracket **4** remains constant.

Alternatively, the position of stopping means **23** can be adjustable. By adjusting the position of the stopping means, the angle of shelf bracket **4** relative to the ground can be changed. This is because a change in position of stopping means **23** changes the amount by which the side arms **5** can be pushed back, which in turn changes the angle of shelf bracket **4** to the ground. Preferably the position of stopping means **23** can only be adjusted within certain parameters, the limits of which ensure that the angle of shelf bracket **4** is always within an ergonomically acceptable range.

If stopping means **23** is movable, its position may be adjusted by a variety of means, such as with a sliding track with a locking mechanism, or with a rack and pinion mechanism, or with a pneumatic cylinder. One preferred means, however, is by way of a screw-type mechanism, as shown in FIGS. 7-9. Knob **27** is connected by threaded bolt **28** to stopping means **23**. Threaded bolt **28** is attached to stopping means **23** by being screwed into threaded aperture **29** in stopping means **23**. As knob **27** is turned in one direction, threaded bolt **28** is also turned; because stopping means **23** and threaded aperture **29** cannot also turn (because of geometric constraints within mounting bracket **3**), the turning of threaded bolt **28** in one direction forces it to unscrew from threaded aperture **29**, pushing stopping means **23** towards the front of mounting bracket **3**. The turning of knob **27** in the other direction has the opposite effect. The degree to which threaded bolt **28** can be screwed or unscrewed from the threaded aperture **29** (and hence the degree to which stopping means **23** may be moved) may be governed by the use of mechanical stopping means as shown in FIGS. 8 and 9. FIG. 9 shows a top view of

the mechanism. As may be seen from the drawing, stop rod **42** runs parallel to center piece **38** of stopping means **23**. FIG. 8 shows a side view of mounting bracket **3** with stopping means **23**. Stop rod **42** is fixed in place and is vertically positioned in the middle of ends **37** of stopping means **23**, running through ends **37** via third openings **43** (only one shown). As stopping means **23** moves back and forth relative to mounting bracket **3** from the turning of knob **27**, third openings **43** move relative to stop rod **42**. Once stop rod **42** reaches an end of third openings **43**, stopping means **23** cannot move any further in that direction. The dotted lines in FIG. 7 show stopping means **23** in a ~~forwardly displaced position compared to the position shown in the solid lines.~~

Other simple mechanical means may also be used to limit the amount by which stopping means **23** can be moved.

Another screw-type mechanism for adjusting the position of the stopping means is shown in FIGS. 13-16. As shown in FIG. 13, sliding bracket **46** is adjacent to mounting bracket **3**. Sliding bracket **46** is shown in more detail in FIG. 15. Stopping means **23** are attached to sliding bracket **46** by conventional means, such as rivets or screws. Sliding bracket **46** has, near to where stopping means **23** are attached to it, fourth openings **53**, through which passes stop rod **42**, which is attached to mounting bracket **3**. As was discussed above in connection with FIGS. 7 and 8, the interaction between stop rod **42** and fourth openings **53** limits the amount of possible back and forth movement by the mechanism.

Sliding bracket **46** is attached to setting bracket **47** (shown in more detail in FIG. 16) by means of attachment pin **48** which passes through opening **49** in setting ~~bracket 47 and openings 63 in sliding bracket 46 (shown in FIG. 15)~~. Setting bracket **49**

is attached to mounting bracket **3** by means of attachment rods **50** and **51**, which pass through holes **52** (see FIG. 16). Opening **49** is angled so that as setting bracket **47** is moved from side to side relative to mounting bracket **3**, attachment pin **48**, which must slide within the confines of opening **49** is forced to move either forward or backward, which in ~~turn forces sliding bracket **46** and stopping means **23** to also move forward or backward.~~

For example, looking at FIG. 14, if setting bracket **47** is pushed to the left, it is easy to see that attachment pin **48** will be forced along opening **49** towards the front of mounting bracket **3**, forcing sliding bracket **46** to also move forward, carrying stopping means **23** forward also. By varying the angle of opening **49** it is possible to control how much sideways movement of setting bracket **47** will force forward movement of sliding bracket **46**.

In the embodiment shown in FIGS. 13 and 14, the lateral position of setting bracket **47** (and hence sliding bracket **46** and stopping means **23**) is adjusted by means of knob **54** in combination with threaded attachment rod **50** and threaded fastener **55**. Threaded fastener **55** is attached to setting bracket **46** adjacent to one of the holes **52**. Threaded attachment rod **50** passes through one hole **52** and threaded fastener **55**. One end of threaded attachment rod **50** is attached to knob **54** (which is positioned on the outside of mounting bracket **3**), while the other is rotatably fixed to the opposite side of mounting bracket **3**. When knob **54** is turned by the user, it turns threaded attachment rod **50** and causes it to interact with threaded fastener **55**. Because threaded attachment rod **50** is rotatably fixed, threaded fastener **55** is forced to "migrate" up and down threaded

attachment rod **50**, causing setting bracket **46** to move laterally, and the rest of the mechanism to move forwards and backwards as described above.

A related mechanism for adjusting the position of the stopping means **23** is shown in FIGS. 17-19. In this embodiment, the position of the stopping means **23** is adjusted by means of sliding bracket **46** in combination with setting bracket **47a**. However, the lateral position of setting bracket **47a** is not adjusted by means of threaded screw mechanism as described above, but rather by means of adjustment lever **56**. Setting bracket **47a** differs from setting bracket **47** in that it includes a laterally protruding wing **59**, which has within it a hole **60**. Position bracket **57** is fixedly attached to mounting bracket **3**. Adjustment lever **56** is pivotally attached to position bracket **57** by pin **58**. Adjustment lever **56** is attached to setting bracket **47a** by means of pin **61** which passes through hole **60** in setting bracket **47a** and through slot **62** in adjustment lever **56**.

When the handle **63** of adjustment lever **56** is moved by the user, adjustment lever **56** pivots around pin **58**. This in turn forces movement of slot **62** relative to mounting bracket **3**. Because of the attachment of setting bracket **47a** to adjustment lever **56** by means of pin **61** through slot **62**, movement of slot **62** forces lateral movement of setting bracket **47a** along attachment rods **51**. As discussed above, ~~this in turn provides forward and backwards movement of stopping means 23.~~

Depending upon the exact mechanism used to adjust the stopping means, such adjustment can be easier or more difficult for the user. For example, if the stopping means can only be adjusted using a screwdriver (instead of by the mechanisms described ~~above) it will less convenient to adjust. This arrangement may be desirable for some~~

applications, where it is sought to minimize the number of adjustments which can be made by the immediate user.

The primary purpose behind adjusting the stopping means is to adjust the angle of keyboard shelf **4** relative to the ground. The farther forward stopping means **23** is positioned, the greater the elevation of the front of shelf bracket **4**, and vice-versa. An alternative means for adjusting the horizontal orientation of shelf bracket **4** which is particularly useful when stopping means **23** is not adjustable is by means of conventional locking knob **31**, as shown in FIG. 1. Bolt **14** is screwed into locking knob **31**. When locking knob **31** is turned, bolt **14** is prevented from also turning by the interaction of its square end with lateral opening **16**. The threaded connection between locking knob **31** and bolt **14** forces locking knob **31** to move in towards spacer **41**, forcing side arm **5** and lower arm **17** into closer contact with spacer **41**. This eventually tightens the system to the point where neither rotation or lateral movement of lower arm **17** or side arm **5** about bolt **14** is possible. To facilitate the "squeezing" of lower arm **17**, its rearward sections around and adjacent to openings **20** do not have a bottom section connecting them, unlike at the its forward sections around and adjacent to fourth pivot rod **18**.

When locking knob **31** is used, the angle of shelf bracket **4** can be adjusted by tilting the front of shelf bracket **4** up, pulling side arm **5** away from stopping means **23** and locking shelf bracket **4** into this position by tightening locking knob **31**. By "locking" side arm **5** at a position where it is pulled away from stopping means **23**, the angle of shelf bracket **4** can be altered from what would permitted by the use of stopping means **23**. The use of locking knob **31** is preferred when only one side arm **5** and one

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stopping means **23** are used, and when stopping means **23** cannot be moved. Locking ~~knob **31** can also be used in conjunction with a movable stopping means.~~

Other similar, known friction-based systems, such as stopping means with handles, can be used in place of locking knob **31**.

The height at which shelf bracket **4** is maintained during use or storage relative to desktop **36** is controlled by the interaction of side arms **5** and stopping means **23**. Each side arm **5** contacts the first side **24** of stopping means **23**, stopping the rearward motion of the side arms **5** and keeping the shelf bracket **4** at a constant angle relative to the ground. By tilting the front of shelf bracket **4** up, each side arm **5** is pulled away from its respective stopping means **23**, permitting vertical movement of the auxiliary shelf mechanism **1**. When the front of shelf bracket **4** is released, each side arm **5** once again contacts its respective stopping means **23**. The curved end **21** of each side arm **5** does not slide relative to its respective stopping means **23** because of friction. Placing additional weight on shelf bracket **4** simply causes the curved ends **21** of the side arms **5** to "dig" into each stopping means **23** even more, further inhibiting vertical movement of auxiliary shelf mechanism **1**.

This friction based impediment to movement is enhanced by the use of a preferred configuration of stopping means **23**. In this preferred embodiment, first face **24** of stopping means **23** is concave and has a 45° chamfer directed towards the outside of the mechanism (i.e. towards the mounting bracket). (One of skill in the art will readily appreciate that the angle of the chamfer can be varied.) This is shown in more detail in FIG. 10. This chamfer "funnels" the side arm into a corner created by the stopping means and the mounting bracket, as shown in FIG. 11. The increased amount of friction

resulting from this arrangement results in greater vertical stability for auxiliary shelf mechanism **1**.

An alternative means for improving the vertical stability of auxiliary shelf mechanism **1** involves providing curved ends **21** of side arms **5** with a series of "teeth" which can cooperate with a complementary series of "teeth" on the first side **24** of stopping means **23**. The interaction of the teeth on curved end **21** and the first side **24** can prevent vertical movement of auxiliary shelf mechanism **1**. A further alternative, shown in FIG. 12 is to attach a pivoted side-arm cam **45** to curved end **21** of side arm **5** by means of pin **44**. The curvature of pivoted side-arm cam **45** complements that of first side **24**, thus maximizing the contact area between the surfaces and the amount of friction between them, resulting in greater vertical stability for auxiliary shelf mechanism **1**.

Any of the foregoing methods for vertically stabilizing auxiliary shelf mechanism **1** may be used in combination with any of the others (e.g. teeth may be placed on pivoted side-arm cam **45**, and curved face **24** of stopping means **23**).

Regardless of what system (if any), is used to stabilize the vertical positioning of auxiliary shelf mechanism **1**, the use of the stopping means/side arm mechanism permits the user to adjust the height of the keyboard in a facile, intuitive manner, without the need to reach awkwardly around the keyboard and fumble for levers or knobs. Moreover, this system is also mechanically quite simple, does not require the complex locking mechanisms of prior art devices, and presents a significant improvement over those devices.

FIG. 6 shows the means by which lateral movement of auxiliary shelf mechanism **1** is achieved. Mounting track **22** is attached to the underside of desktop **36**,

normally so that it is perpendicular to the front edge of desktop **36**. The outside edges of mounting track **22** are configured so as to form a pair of inwardly facing, C-shaped brackets **34**. Swivel bracket **32** is shaped so that it will fit into the C-shaped brackets **34**. Swivel bracket **32** (and the rest of auxiliary shelf mechanism **1**) can be moved by simply pushing the mechanism back and forth along the track. Unwanted lateral movement of auxiliary shelf mechanism **1** is controlled by friction between swivel bracket **32** and C-shaped brackets **34**. Moreover, when weight is placed on shelf bracket **4** (for example when a keyboard and/or a pair of hands is resting on it), this will have a tendency to cause swivel bracket **32** to tilt forward, causing the rear of swivel bracket **32** to contact the top of C-shaped brackets **34**, increasing the friction-based resistance of auxiliary shelf mechanism **1** to lateral movement. If desired, an additional locking mechanism may be provided to prevent lateral movement, but such a mechanism is generally unnecessary and makes adjustment of the position of auxiliary shelf mechanism **1** more cumbersome. Mechanical stops (not shown) may be employed at either end of C-shaped brackets **34** to ensure that auxiliary shelf mechanism **1** does not slide off mounting track **22** and fall to the floor.

As an alternative to C-shaped brackets **34**, downward facing T-shaped tracks may be used in conjunction with compatible structures on the mounting bracket, such as is set forth in U.S. Patent No. 4,644,875. Other known means for mounting auxiliary shelf mechanism **1** to the underside of the desk can also be used.

Swivel bracket **32** is attached to swivel bracket assembly **33**, mounting bracket **3**, and mounting bracket support **6** by means of a rivet (not shown). A large washer **35** is fitted between swivel bracket **32** and mounting bracket **3**. The washer may

be made of any number of hard and slippery materials, including metals, but is preferably made of a hard plastic such as polyethylene, and most preferably made of nylon. Mounting bracket support **6** is attached to the inside of mounting bracket **3**. Generally, that attachment will be fixed (for example by spot welding or flat rivets). Therefore, when lateral force is exerted against auxiliary shelf mechanism **1**, mounting bracket **3** will tend to rotate around the rivet relative to swivel bracket **32**, which is prevented from rotating by the C-shaped brackets **34** of mounting track **22**. Thus, auxiliary shelf mechanism **1** can be rotated relative to the mounting track **22** and the desk top, as shown in FIG. 4. The rotational mechanism described herein is known in the art, and other known mechanisms may also be used.

The materials used in the construction of auxiliary shelf mechanism **1** can be varied, but will be a stiff material for most components, preferably steel or another metal or metal alloy. In a preferred embodiment, curved ends **21** of side arms **5** and first sides **24** of stopping means **23** will have surfaces which are rough enough so as to limit their ability to slide past one another, locking the system in place as described above and enhancing its vertical stability.

Another advantage of the present invention is that the shelf bracket is the part of the auxiliary shelf mechanism **1** which is closest to the ground. Nothing projects below shelf bracket **4** as in other prior art mechanisms, such as is shown in U.S. Patent Nos. 5,257,767 and 4,616,798, described above. Thus, when the keyboard is pushed beneath the desk, the amount of leg room is maximized. This is achieved by attaching the various arms connecting mounting bracket **3** to shelf bracket **4** to the top and side of shelf bracket 4.

The present inventors have found that by equipping the shelf bracket with an upwardly extending piece to permit attachment of link means, the vertical profile of the overall mechanism can be shortened, increasing the leg room available to the user when the keyboard is positioned beneath the desk. Thus, another aspect of the present invention is the attachment of an auxiliary shelf (or keyboard shelf) to a desk top, so that the auxiliary shelf can move both horizontally and vertically relative to the desk top, the attachment being made so that nothing extends below the bottom of the auxiliary shelf. This arrangement maximizes the amount of leg room beneath the auxiliary shelf. The attachment between the auxiliary shelf and the desk can be made by either a parallelogram linkage, or by a non-parallelogram linkage, or by a linkage of the type described in detail in this application (i.e. upper arm-side arm-stopping means).

One means by which this type of attachment may be accomplished is by using an auxiliary shelf with a vertically oriented piece attached to its rear side. The linkage can be attached to this vertically oriented piece, precluding the need for anything to project beneath the auxiliary shelf. For example, shelf bracket **4** is shaped in such a way that a more conventional parallelogram linkage or non-parallelogram linkage could be used, instead of the upper arm-side arm-stopping means system shown specifically in the drawings. Other attachment means may also be used, as will be readily apparent to those of skill in this area.